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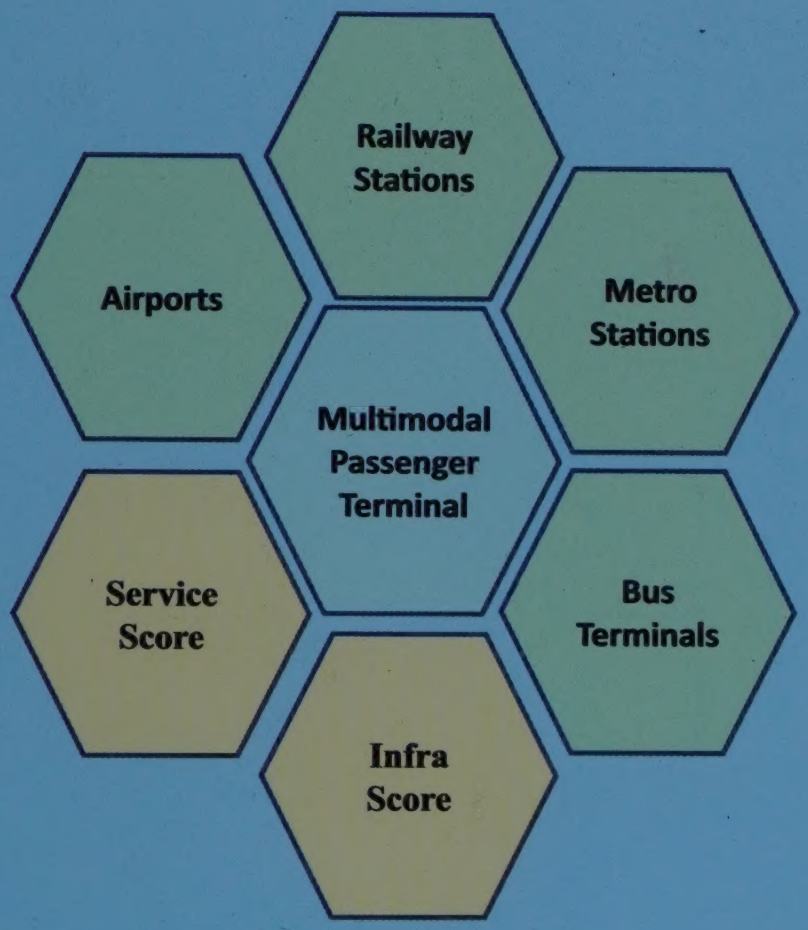
GUIDELINES FOR MULTIMODAL PASSENGER TERMINALS



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GUIDELINES FOR MULTIMODAL PASSENGER TERMINALS

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1 INTRODUCTION

These Guidelines have been prepared in pursuance to the first meeting of the Multimodal Transport Systems Committee (G-6) held in 23.10.2021 and subsequent review meetings. As these Guidelines are first of its kind in IRC with an immense value towards enhancing road safety, accordingly, the work of preparation of new document on "**Guidelines for Multimodal Passenger Terminals"** was taken up by the Multimodal Transport System Committee (G-6) during its tenure 2021-2023 under the convenorship of Dr. S. Gangopadhyay. The first draft of the guidelines was prepared by the Sub-Group comprising of Prof. P.K. Sikdar, Convenor of the Sub-group and Dr. Samson Mathew, Shri P.J. Mishra, Prof. Geetam Tewari, Shri V.D. Sardeshmukh, Dr. Mukti Advani and Shri Vikas Thakkar as members. The draft was discussed and deliberated in a number of meetings of G-6 Committee. The draft prepared by the Sub-group under the convenorship of Prof. P.K. Sikdar, has gone through many changes from time to time so as to arrive at consensus view.

These guidelines have been finalized by discussion and presentations in several meetings, and rigorous review held on the shared draft guidelines. During the 14th meeting of G-6 Committee held on 7th March, 2024, the draft guidelines were approved for submission to the GSS Committee. The list of personnel of the G-6 Committee is as under:

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The finalized draft was placed before the General Specifications and Standards Committee (GSS) in its meeting held on 23rd May, 2024 and was approved for placing before Executive Committee and IRC Council. The Executive Committee in its meeting held on 13th June, 2024 considered and approved the same for placing it before the Council. The IRC Council in its 228th Meeting held on 14th June, 2024 at Siliguri (West Bengal) considered and approved the guidelines for printing.

2 PASSENGER TERMINALS

2.1 Introduction

Every passenger terminal is designed to serve passengers and the provision of infrastructure for multimodal service supply will be dependent on the level of demand. Therefore, the performance of these terminals is significantly dependent on its design, as well as its level of integration with available travel modes of the city, i.e. metro, suburban train, long distance train, bus, auto rickshaw, car/taxi, two wheelers, pedestrian and other NMT modes. For terminal design, many guidelines are already prepared for various terminal types including airports, railway stations, interstate bus terminals, bus stops/ports, metro stations, waterway stations, ropeway stations, etc. The list of such available guidelines is included at the end of this document. The scope of this document is multimodal integration of a passenger terminal with various travel modes used for access/egress to the terminal as well as transfers between modes. Accordingly, this document focuses on facilitation of multimodal integration so as to provide convenience to passengers/commuters using the terminal to avail any other mode of access/egress and transfer by choice. Document provides the guidelines for multimodal integration for convenient and seamless transfer between primary modes as well as convenient use of the access/egress modes. This document also provides an Excel tool for measuring the multi-modality of a terminal. Other aspects of integration, i.e. institutional integration framework, transport system integrations using trip planner through combined operational schedules, etc, are handled separately by other extant IRC codes.

2.2 Scope of the Document

This document provides for the need of developing the passenger terminals with respect to its multimodality. The scope of this document is limited to all types of passenger terminals only, and those handling freight is not part of this document. Multimodality at a terminal is dependent on how close of the different modes are located within the vicinity of a terminal and with what ease those can be accessed. This has been measured through two groups of parameters, in terms of infra score and service score, which are based on infrastructural facilities and based on services provided to users respectively, where the service score is reflection in terms of ridership or patronization share of different modes.

3 MULTIMODAL INTEGRATION AT TERMINAL

The multimodal integration depends on how all modes have been accommodated (provided for) and integrated at the surrounding network and most importantly at the terminal itself. At the terminal, as users of different modes interact, a suitable design to ensure clarity of movement path (circulation within the terminal) and safety play a crucial role in effective integration. Multimodal terminal design needs to ensure that multiple modes are served with the objectives of sustainable mobility, accessibility, connectivity and safety.

In India, passenger terminals (both intra- and inter-urban) are required to handle or accommodate a range of vehicle types (which serve as the feeder to the terminal) serving primarily public transport (trains/bus), especially the intermediate public transport (Auto, cycle rickshaw, taxi, mini-bus and e-rickshaw), as well as private modes (walk, bicycle, two-wheelers, and cars). IPT and public transport modes are generally found to be operating in second order cities with structured/un-structured routes and schedules. Apart from all these vehicular and NMT modes facilitating coming-in and going-out of passengers, other formal/informal service providers (shops and street vendors, etc.) are commonly found to be existing in the terminal and the surrounding area. Depending on the type of terminal, i.e., air/rail/road/water, these service providers range from informal hawkers (street vendors) and fast-food restaurants/eateries to planned/structured and branded shops planned and designed as part of the terminal facility. These wide-ranging facilities, as normally required in any of the terminals, make it challenging to plan and design the terminals. This is particularly so within city terminals, unless all such requirements are duly considered at the time of initial planning.

This document includes the guidance with respect to the principles to be adopted while planning and designing for the development of a new passenger terminal or while upgrading an existing terminal for multimodal integration. This document aims at providing a simple Excel tool to measure the level of multimodality facilitated at any terminal. Thus, this can be utilized to assess the level of multimodality of an existing terminal based on various design features in respect of accessibility for various passenger modes. Also, the tool can be used to assess the rating of multi-modality at the stage of design itself or for any upgradation/modification proposed in case of an existing terminal.

3.1 Scale of Facility & Space for Various Amenities

The various amenities required at a terminal depend on the type of trips/journeys handled by the terminal, depends on whether long (inter-city/state) and/or short (intra- city) trips are served by the terminal. Types of travel also determine whether it will involve carrying/handling of luggage or not. Also, the scale of the terminal facility will be determined by the volume of demand to be catered to and the nature of travel. Within the scope of multimodal passenger terminal, the following two broad categories have been considered in this document.

a) Multimodality for terminals handling intra-city trips, and
b) Multimodality for terminals handling inter-city trips

City bus stops/terminals, metro stations and city/suburban rail stations are generally considered in category A, while three types of terminals, such as airports, railway stations, and interstate bus terminals, are considered in category B. Brief characteristics of these terminal types are given below for clarity.

3.1.1 *Airports (International/Major Airports/Domestic)*

The airports need to be connected by all public transport modes in the city, which are road and rail based. Depending on the volume of air passenger traffic of the airport, coordinated routing and scheduling of local public transport systems are required to be ensured. The access path from the airport exit gate to the nearest public transport stop/station should be walkable and easy for handling baggage on the way. In terms of the distance between airport exit and public transport stops/stations, it should be as close as possible, however not to be more than 250 meters away and in no case, it should be more than the nearest taxi stand. The path between the airport exit and public transport stop/station should be kept (i) protected from motorized vehicles, (ii) fully illuminated, (iii) protected from sun and rain, and (iv) supported by direction signages.

Intermediate public transport stands including car/two-wheeler parking need to be connected with the airport terminal. Private vehicle pick-up and drop-off should be kept no closer than the public transport stop/station. However, facilities for people with limited physical abilities are to be addressed through standard design as per international practice.

3.1.2 *Railway Stations*

Railway stations need to be well connected with all public transport and intermediate public transport modes of the city. Physical connectivity between exit gates of railway station should have the closest public transport stop/station at a distance not more than 100 meters. In case of multiple exits, each gate must have an option of public transport within the mentioned distance limit. Similar to the airport terminal, at railway stations also the access/egress path between the entry/exit gates and public transport stop/station should be kept (i) protected from motorized vehicles, (ii) fully illuminated, (iii) protected from sun and rain, and (iv) supported by direction signages.

3.1.3 *Interstate Bus Terminals (ISBTs)*

Irrespective of its hierarchy (interstate or local within city terminal), bus terminals are categorized under three levels of total turnover of buses per hour (as per use of the terminal), viz. (i) Large (more than 300 buses per hour), (ii) Medium (more than 60 up to 300 buses) and (iii) Small (less than or equal to 60 buses per hour). This classification is as per a report by Shakti Foundation.

Based on the terminal size in-terminal vehicle (bus) maintenance area, parking bays for buses, boarding/alighting area, waiting area for passengers, and ticket counters, etc shall be planned. The facilities for access and egress modes shall be similar to the railway stations.

3.1.4 *City Metro/Bus Terminals/Stops*

The city level metro and bus stands/stations/terminals are usually accessed by a high share of walking trips. Similarly, major bus stops used by multiple routes are also having similar access mode proportions. Such terminals shall have exclusive bay for intermediate public transport connectivity (auto-rickshaw, shared auto-rickshaw/e-rickshaw, feeder buses, etc.). In all such cases, it is essential to encourage and promote accessibility of feeder public/intermediate public transport modes. In case of space constraints, higher priority shall be for NMT and public transport modes compared to the circulation for private modes.

3.1.5 *Ropeway Terminals*

i) At present, ropeway technologies that have been used as mass transit modes in urban areas include five technologies: Aerial Tramways, Dual-Haul Aerial Tramways, Mono-cable Detachable Gondolas (MDG), Bi-cable Detachable Gondolas (BDG), Tri-cable Detachable Gondolas (TDG)

ii) Ropeways do provide connectivity to inaccessible areas, especially in hilly and difficult terrains, where the road, rail and air transport networks are limited. Ropeway terminals are similar to any other terminal, where passengers (both able & disabled / physically challenged persons) board and disembark on/from their cable-car ride. Integrated operation schedule of ropeway and other modes available at the terminal will provide seamless travel with easy and quick transfers. Access within the Site a) The main access to any component shall have adequate width not less than 7.5 m. b) An unobstructed area of minimum width of 3 m shall be provided around each built structure in the premise for Fire Tender movement. Also, such terminals will have many access modes depending on the level of demand for travel using ropeway, land requirement to be worked out, designed and constructed as per Demand –

estimation, Terminals shall be Earthquake and Flood resistant structures, Slope-protection features, Energy efficient designs & utilities, Water Conservancy.

iii) In general, two terminals are mainly there: a drive terminal (upper) and a return (idle) Lower terminal. The drive machinery may be installed overhead or in an underground vault, based on design and land availability at upper and lower terminals at any project site or making angles/curves/change in direction - stations are required (for more than 5 degrees). Some systems that use Gondolas might have few intermediate stations as well to pick up and drop off passengers between the drive and return terminals. All terminals must have adequate Information Signs, Facility Signs, Parking areas demarcation, necessary Rescue & safety system, PA systems, Waste-management System.

iv) Design of the Aerial Ropeways shall be strictly in line with the guidelines issued by BIS,MoE & FCC (GoI) and guidelines issued by Central (Parvatmala - National Ropeways Development Programme and State Governments, Norms of Fire-Service dept. CEN/European Global Safety Standards & Regulations of Ropeway be adhered to as per technical requirements.

3.1.6 *Waterway Terminals*

i) To augment the capacity of waterways transportation in India, Govt. of India has constituted Inland Waterways Authority of India (IWAI) in 1985. IWAI has initially identified 5 river stretches Project area under Jal Marg Vikas Project on National priority and notified these stretches as National Waterways. Amongst the five notified waterways, the national waterways on Ganga (NW-1 between Haldia to Allahabad) is the longest waterway and is of prime importance for Freight movement.

ii) Selection of Site for Passenger terminals/jetties be made on the basis of potential of Passenger generation of the area and its connectivity with other modes of transport (rail & road).A multimodal water transport passenger terminal facilitates the access and linkage of passengers between water-based modes of transportation and other modes of transport.

iii) *Design Planning:* After selection of site for development of the terminals, alternatives are to be selected for layout design and alignment of proposed roads and railways for connecting the site. This helps to optimize the project cost during construction as well as during operation phase. Such alternatives be considered at few locations as per the requirement of locations. Alternative layout designs and location of road/rail alignment to provide connectivity be assessed. Provision of navigation aids; river information system; RO-RO jetties; bank protection / slope protection works; river training works; inland vessels; survey vessels, survey equipment and dredging facilities which are required to be developed in a phased and programmatic manner. The multi-modality of the terminal should serve as a hub for passengers to access the terminal and transfer from other land-based modes of transportation such as public (buses, trains, metro, etc), IPT (taxis, auto-rickshaw, feeder buses, etc) as well as NMT modes. In-terminal facilities will include ticketing counters, waiting areas, restrooms, baggage storage, and parking for cars and bicycles, as well as food and beverage outlets, retail shops, and other amenities.

3.2 Design Principles for Methodology for Multimodality

The key principle of planning and designing a multi-modal passenger terminal is 'to design like a public space' in terms of its accessibility. Since public space is expected to handle users of all ages and gender groups with a range of physical abilities, its planning needs careful consideration of the access needs of all such patrons. In addition, the priority of various users in the terminal area (in the context of access modes to the terminal) should follow the well-known reverse pyramid/trapezoid of priority as shown in **Fig. 3.1**.

Fig. 3.1 Reverse Pyramid/Trapezoid of Priority for Access Planning

The other principles considered for better multimodality for access planning to the terminals are:

3.2.1 *Site Selection Criteria for a New Major Terminal (New Airport/Railway Station)*

Airports inside the city or in the proximity (in or adjoining the Development Authority area) should be preferred for possible multi-modal accessibility. This provides easy and faster access to airports using various available modes of the city. Many airports have been shifted to the locations at a distance (for advantage of an open area) and developed it with transport intensive land use, which usually results in accessibility primarily by private cars or taxi services only. In all such cases (where it is unavoidable), high-speed high-occupancy modes (like rapid transit system) should be planned and developed along with the airport itself to ensure ease of access.

3.2.2 *Coordination with Regional Transport Strategies and Local Transport Plans*

The airport/railway station terminals are to be planned considering the long term future demand estimates. Therefore, it shall be planned and designed as an integral part of city's land use and mobility plan in due consideration and in alignment with the Development Authority's plan for future developments.

3.2.3 *Reducing Discontinuities/ Facilitating Intermodal Connectivity*

At terminals, it is necessary to provide a smooth and seamless transfer between modes, and for this the transfer path needs to be continuous, safe and protected. Further, access to various feeder modes (bus, rickshaws, walk, and private vehicles, etc.) should be carefully considered in the circulation network with deliberate priority to pedestrian and NMT modes. It is essential to ensure an acceptable level of accessibility and conflict free movement of users.

3.2.4 *Fostering Non-Motorised Transport Modes*

In case of terminals located inside the city area, smooth access through walk and non- motorised modes should be ensured to encourage sustainable transport. Apart from allocation of dedicated space for walking, efficient and safe circulation plan for bicycle and cycle rickshaw (wherever exist) needs to be ensured. Role of intermediate public transport is prominent in small/medium sized cities and should be supported well through planning and design of their access and circulation to reduce trips made by private vehicles like car and two-wheeler.

3.2.5 *Accessibility and Safety for all Road Users (of Ability, Gender and Age)*

India's Disability Act of 1995 suggests that public infrastructure be barrier-free for all. This implies that terminal facilities should be inclusive and accessible for all, including differently-abled people, elderly persons, people carrying luggage, pregnant women, children, and people traveling with infants (in hand or stroller), etc. All travelers should be able to transfer or access the journey mode safely in a seamless manner with minimum effort.

3.2.6 *Parking Facilities & Pick-up/Drop-off around Terminal*

At any terminal, parking facility and pick-up/drop-off zones do play a major role towards the ease of accessing the public transport mode. Among all the modes used for this purpose, sustainable modes are required to be prioritized at all types of terminals.

Parking areas to be designed considering the short-term and long-term parking demands. Short term parking or pick-up/drop-off bay/platform needs to be well connected by walking paths. At the airports/railway stations, the passenger movement is expected to be slower with baggage, and therefore, the crosswalks and traffic signals at the network adjacent to such terminal are to be designed accordingly.

3.2.7 *The need of Re-balancing of space & investment in line with Multimodal Transport*

Space is one of the major constraints, especially in urban area, which makes it challenging to design good circulation plans for all modes around the terminal area. In such cases, parking for private vehicles shall be with lower priority in terms of utilization of space for promoting multi-modality for access to the terminal.

Though, strategies of having higher priority for sustainable modes are not unknown, but their implementation is generally compromised considering the limitation with respect to space availability. To discourage the usage of more space by private motorized vehicles, prioritizing the space for sustainable modes (viz., walking, cycling, and intermediate public transport) is required with more organized multimodal accessibility. This process can be slower, but essential for long term benefits, which is known as Gradual Sustainability Approach (GSA), (Advani, 2021).

A few examples of identifying potential space around metro stations located in metropolitan area are being presented in photographs (refer **Figs. 3.2, 3.3 & 3.4**), which are not used with deliberate priority for sustainable modes. The elevated metro stations have space under the stations and FOBs/Skywalks for planning suitable parking and pick-up/drop-off stands for public transport and IPT modes. **Figs. 3.2, 3.3 & 3.4** shows such a possible space in the case of a city terminal (Metro station). These examples are from Metro stations in Delhi; however, similar situations can be found in other cities for Metro stations and other terminals.

Fig. 3.2 Space under Metro Foot Over Bridge (Laxmi Nagar, New Delhi)

Fig. 3.3 Space Outside Metro Station (Near (Kailash Colony Metro Station, New Delhi)

Fig. 3.4 Space Outside Metro Station (Ashok Nagar Metro Station, New Delhi)

3.2.8 *Standardized Guidance for Multimodal Integration*

At the terminals, signs for guiding the paths to all available access/egress modes are to be marked or displayed for easy and fast comprehension. It is also useful to provide approximate distance mentioned on such guiding path markings to keep the users informed. Such information could be a decisive parameter for their choice. Examples of floor marking for displaying the direction and distance are shown in **Fig. 3.5**.

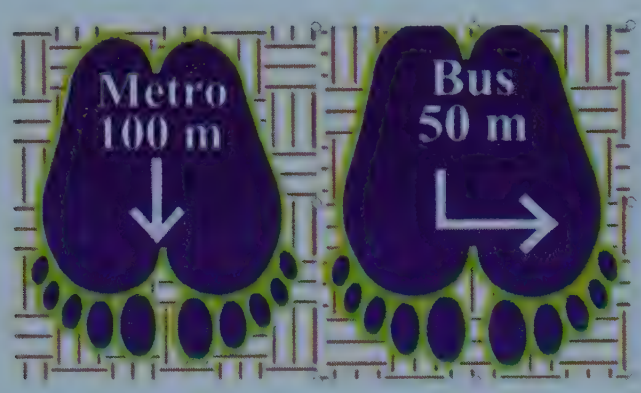

Fig. 3.5 Access/Egress Path Markings

Broad methodology to ensure multimodal integration based on design principles suggested in para 3.2 is given below in terms of multimodality to be achieved through the following steps:

i) Design the area outside the terminal (the surrounding network) with minimum distance to various feeder modes.

ii) All modes of transport operating in the city should be well connected to all terminals (i.e. metro, bus, car, auto-rickshaw, other rickshaws, two wheeler taxi, etc.).

iii) Design public transport pick-up and drop-off (bus stops/ metro stations) closer to the entry/exit gate of major terminals (intercity terminals), especially in case of airport and railway stations.

iv) Car/two-wheeler parking to be located at a distance farther than bus stops/metro stations.

v) Airport locations should be prioritized as per the guidelines of Civil Aviation, at a location with logical distance from the city center, as against a transport intensive access /egress requirement

vi) The movement of commuters (passengers) from terminal entry/exit to public transport stops/stations and parking areas should be well connected, weather protected, well maintained, conflict-free, well informed (distance & direction signs), and completely hazard-free.

4 MULTIMODAL TERMINALS HANDLING INTRA-CITY TRIPS

The most typical terminals handling intra-city trips are the major bus stops/terminals and metro stations. The level of demand and trip characteristics of commuters using these terminals (in terms of their access/egress modes) are to be assessed and understood for suitable multi-modality design solutions. The steps in which the multimodality should be planned are described in the following sections.

4.1 Demand Estimation

The ease of transfers at bus stops and metro stations is one of the significant parameters influencing the riders. This transfer can be between two main haul line trips or most commonly between access/egress (first mile/last mile connectivity trips) and main haul line trips.

Access/egress trips made for availing main haul bus/metro trips generally range over a wide variety of modes including walk, bicycle, cycle rickshaw, electric rickshaw, auto rickshaw, shared auto-rickshaw, motorised two wheeler, radio taxi, car, bus, etc.

For any major bus stop or metro station, prior to planning for any integration among various access/egress modes, it is important to know the accurate estimation of demand. This includes ridership information for the main mode at the stop/station as well as the composition / modal split for the access and egress trips made.

For existing situation, demand can be captured through sample survey of data collection through personal interviews at the terminal during peak hours. This is to capture access/egress modes of commuters or patrons of the terminal. In absence of any such survey data regarding the access/egress modes, recommended practice shall be as follows:

i) for bus stops, it is suggested to consider 80% and 30% access/egress by walk and all other modes respectively.

ii) for metro stations, it is suggested to consider 40% walk, 50% for IPT and personalized vehicles respectively.

Available data/information: As per SUSTRANS study (CRRI, 2017), to cover 20% of the distance of the total journey for access / egress, metro being major mode, passengers had to spend 42% of their journey time

and 52% of their total trip cost. (**Table 4.1**). This data shows the time and cost spent in access to a terminal of a major mode like metro. As access and egress part of any trip has major impact on the level of multimodality of a trip, efficient circulation plans should be adopted at the terminal to ensure safe and fast access between modes. This will also help in reducing the transfer time spent in access between modes.

Table 4.1 Trip Characteristics of Metro Users in Delhi (Year 2014)

Trip	Trip Distance (km)	Trip Time (minutes)	Trip Cost (INR)
Access	1.8 (11%)	10.3 (22%)	9.60 (28%)
Egress	1.4 (9%)	9.5 (20%)	8.30 (24%)
Main haul	12.5 (80%)	27.4 (58%)	16.40 (48%)
Total	15.7 (100%)	47.2 (100%)	34.30 (100%)
Share of Access & Egress trips in total trip	20.00%	42.00%	52.00%

(Source: SUSTRANS, CRRI Study (2017)

As mentioned by Gupta et. al. (2019), in Delhi access trips to metro stations involve eleven modes, such as walk, bicycle, two-wheeler, cycle rickshaw, electric rickshaw, auto rickshaw, shared auto rickshaw, bus, metro feeder bus, car and other modes. Among all these, more than 50% of access trips were made using non-motorised modes (e.g. walk 49%, bicycle 0.3% and cycle rickshaw 8.8%). Motorised IPT modes (electric rickshaw, auto rickshaw, shared auto) had a combined share of almost 29% and buses catering for around 4% of access trips. About 9% of access trips have been made by private modes (two-wheeler 8% and car 1%). Similarly, for Bengaluru metro stations, the share of access trips made by walk are 47% followed by 19% by bus, 17% by MTW, 11% by auto, 3% by taxi and 3% by private cars (CSTEP, 2019).

Walk being the primary mode for access/egress trips to most terminals, all surrounding roads of bus/metro stops/stations should be provided with segregated/ raised footpath as well as pedestrian signals at intersections. Foot over bridge (FOB), Skywalk, Pedestrian underpass as per the design provisions should be preferred for higher pedestrian volumes for safe pedestrian access. Additionally, no free left turn should be provided in signal phasing at intersections around bus/metro stations.

Various vehicular modes used for access/egress trips generate demand for space outside the bus/metro stop/station (at the access area of the terminal) for circulation. Broadly, the surrounding network and area (space around) of the terminal is divided in to three categories:

i) Parking area for cars/two wheelers/bicycles – for park-n-ride
ii) Drop-off area for car/taxi, two wheelers, and
iii) Designated stands/stops for IPT and PT modes for pick-up and drop-off (all types of rickshaws, bus, etc.)

In case of Delhi metro stations, it is observed that out of total private vehicles parked at metro station (for park-n-ride facility), 71% are motorised two wheelers, 15% cars and 14% bicycles. It is assumed that all vehicles parked in park-n-ride facilities are metro riders only. This is based on a study carried out by CRRI at 7 metro stations in year 2015. This information is for Metro stations in Delhi; however, similar data can be observed in other cities for Metro stations and other terminals for generalizing the proportions of access modes.

4.2 Coordination for Infrastructural Design

At the planning stage of a terminal in city, all stakeholders having an overall perspective and feel of the city should be involved in design of the multi-modal network required to be developed in the surrounding area of the terminal. Agencies involved in ensuring sustainable solutions and those involved in vehicular pollution related aspects should also participate in developing appropriate access network design.

Due to the very nature of urban transport and its obvious connection with the issues of urban development, it is essential to design the terminals considering the surrounding land uses. A network design for the terminal area is required to holistically consider the access/egress modes and their appropriate facilities in the terminal area for a seamless transfer from one mode to another. The infrastructure design, therefore, shall involve several aspects of the facilities to be provided, which are outlined here.

4.3 Design Concepts

4.3.1 *Defining Access /Egress Zone*

An access/egress zone may be understood as the roads and walkways (footpaths) leading to every entry/exit gate or ramp of the metro station and/or bus stop/terminal. From the entry/exit gate of the metro station or location of the bus stop/terminal or rail station, extending to a distance of 500m on either side (or any channel of movement focusing on the station/stop/terminal all around it within 500m radius) be considered as an access/egress zone. This zone refers to an area covering a road network or walkways, i.e. streets, bus stops, intersections, and parking areas located within a radius of 500m. Within this area, all roads should have footpaths as movement of higher number of pedestrians is expected. Further, all at-grade intersections in this zone are to be preferably signalized with a clear pedestrian phase. Further, footpaths/FOBs/Skywalks/ Underpasses within this zone need to be well connected to the terminal with acceptable design (as per IRC 103).

4.3.2 *Provision of Facilities at Terminal*

Existing bus stops and metro stations differ with respect to the facilities and retail zones (for example retail shops, parking, etc.). Accordingly, space around terminals is to be designed for smooth movement (flow) of all access modes. Though the service requirements for users of both road and rail based transport terminals remain the same, generally all such services are considered to be internal design components of a metro/rail station, but this is not the case for bus stops.

At underground/over ground metro stations, various shops are usually the part of metro station design itself. However, in case of at-grade metro stations and bus stops design of organized vending zone may be considered. However, the vending zone should be designed in such a way that it does not restrict the access network or pick-up/drop-off boarding/alighting platform space. Based on the passenger demand at the bus/metro stop/station, size of the vending zone can be adopted.

4.3.3 *Design Provisions of Transfer Zone*

The transfer from access mode to the main haul line mode will take place through the access/egress zone around the terminal. At bus stops, area requirement for boarding/alighting depends on transit vehicle size as well as on demand in terms of number of buses serving the stop during the peak time. Further, the boarding/alighting activity area should be well segregated from the active traffic lanes in consideration of

safety. Alighting passengers should deboard only at the platform of the bus stop, which is a safe area for all age groups, including women and elderly people. In addition, clear and safe paths should be available leading to the pick-up/drop-off points of different access modes.

In case of metro stations, transfer between access mode and metro station should be properly designed to ensure safe and comfortable flow of pedestrians. Design should ensure safe circulation for access modes from de-boarding location to pick-up location planned in relation to entry/exit gate of metro station.

Similarly, transfer zone outside airports as well as railway stations should be designed to ensure safe and fast transfer to/from various access modes.

4.3.4 *Marking & Signage*

Signages and floor/pavement markings for guiding along the movement paths are required to be uniform throughout all the types of terminals including airport, railway stations and city bus stops and metro stations for easy understanding of travelers. Example of suggested sign for this purpose is shown in **Fig. 4.1**, while any other clear markings adopted uniformly will serve the purpose.

4.3.5 *Sample Pictorial Presentation of Design Solutions*

Fig.4.1 presents one of many possible design options for having a cycle rickshaw stand close to a bus stop.

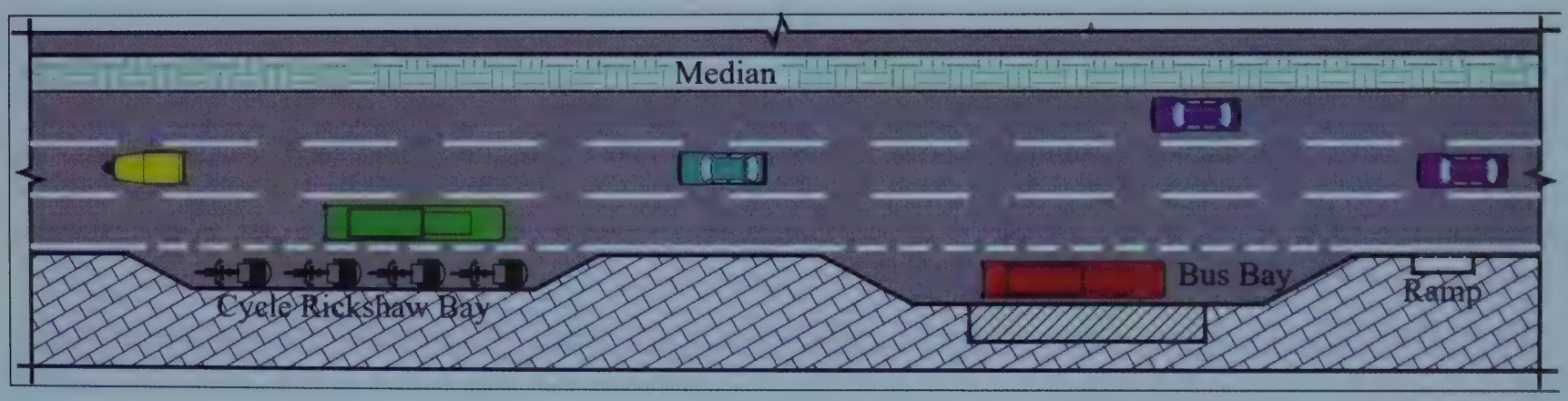

Fig.4.1 Design Option for Having a Cycle Rickshaw Stand Close to Bus Stop

As presented in **Fig.4.1**, Cycle Rickshaw stand for passenger pickup/drop off should be designed as close as possible.

5 MULTIMODAL TERMINALS HANDLING INTER-CITY TRIPS

The most typical terminals handling inter-city trips are interstate bus terminals, railway stations and airports. The level of passenger demand and access trip/ mode characteristics of travelers using these terminals are to be estimated for suitable design solutions.

5.1 Demand Estimation

In case of airports, demand in terms of number of passengers, employees and crew is to be estimated including the access modes used by them. Existing passenger demand served at six major airports in India (RITES, 2016) is given in **Table 5.1** for indicating the level of demand being served.

Table 5.1 Passenger Demand Served at Various Airports

	Delhi	Mumbai	Kolkata	Chennai	Bengaluru	Hyderabad
Passengers (millions)	48.40	41.60	12.40	12.40	18.90	15.10

Source: RITES (2016 on Multimodal Transport Integration Study at 6 Metro Airports)

At airports, demand of passengers and employees has its own characteristics. This demand with its composition is to be considered while designing parking, pick-up/drop- off area and circulation plan around airport. The time duration of private vehicles parked by employees of airport will be much longer compared to the parking required for pick- up/drop off vehicles of travelers. Accordingly, vehicle parking for employees can be at farther distance compared to short term parking required by visitors/travelers.

Table 5.2 presents the details of overall parking supply at six airports as well as peak and daily accumulation at these locations.

Table 5.2 Utilization of Car Parking

	Delhi	Mumbai	Kolkata	Chennai	Bengaluru	Hyderabad
Overall Parking Supply	9650	2579	3921	1708	2006	4361
Peak Accumulation	4488 (46%)	2633 (102%)	1048 (27%)	1061 (62%)	1063 (53%)	1410 (32%)
Daily Accumulation	15883	4505	6759	6096	3607	3723

Source: RITES (2016 on Multimodal Transport Integration Study at 6 Metro Airports)

Further, modal split for accessing these airports by passengers and employees is shown in **Table 5.3**.

Table 5.3 Modal Share of Airport Passengers and Employees (Percentage)

	Delhi	Mumbai	Kolkata	Chennai	Bengaluru	Hyderabad	Average
	Airport Passengers						
Taxi	45.2	47.5	62.2	37.1	48	40	46.6
Car	29.2	24.4	26.2	27.4	29	45	30.2
Bus	12.6	10.64	7.8	22.3	23	15	15.2
Metro/train	9.0	10.76	3.2	12.4			8.8
Auto	2.8	6.56	0.4	0.5			2.6
Two Wheeler	1.2	0.08	0.4	0.3			0.5
	Airport Employees						
Taxi	3.1	5.5	1.3	0.6	17.5	4.0	5.3
Car	33.4	11.5	20.3	16.7	11.5	16.0	18.2
Bus	11.1	34.5	42.3	21.5	51.5	11.0	28.6
Metro/train	2.6	1.5	6.0	42.7	1.5	0.0	9.1
Auto	1.8	14.5	4.30	0.8	3.5	15.0	6.7
Two Wheeler	48.1	32.5	25.3	17.9	14.5	54.0	32.0

Source: RITES (2016 on Multimodal Transport Integration Study at 6 Metro Airports)

With this modal split as given in table, it shows that majority of the passengers and employees are using private vehicles and taxi for their commute to airport. This indicates the deprived facilities for other sustainable modes, i.e. public transport and intermediate public transport modes, which are available in each of these cities, but not to the airports. To provide multimodal character for such airport terminals, surplus parking space may be reorganized to facilitate sustainable modes. This also further suggests the need of mass transit system (high capacity system) connectivity to the airports. Such public transport will be able to cater for higher passenger demand at airports without extra load on private vehicles and taxis on road network of airport area.

In case of existing airports, priority for public transport (various high capacity systems) connectivity is to be ensured through provisions in design and services modifications. Limited area to be dedicated and lower priority to be assigned for facilities required for private vehicles. More area at closer distance to be allotted for the pro-active design improvements supporting the direct connectivity for various public transport systems and other access modes. Directions and pathways to IPT and public transport stations/stops should be abundantly clear for comfortable and safe transfer between entry/exit gate of the airport and drop-off/pick-up bay/platform of these access/egress modes.

Similarly, demand for access/egress modes of railway stations, inter-city bus terminals, inland water transport terminals (IWT terminals), etc. are to be estimated in a similar way based on location specific data.

5.2 Pictorial Presentation of Design Solutions

As presented in **Fig. 5.1**, at railway stations, access to public transport (Bus) and intermediate public transport (taxi/auto) can be kept closer and visible from exits.

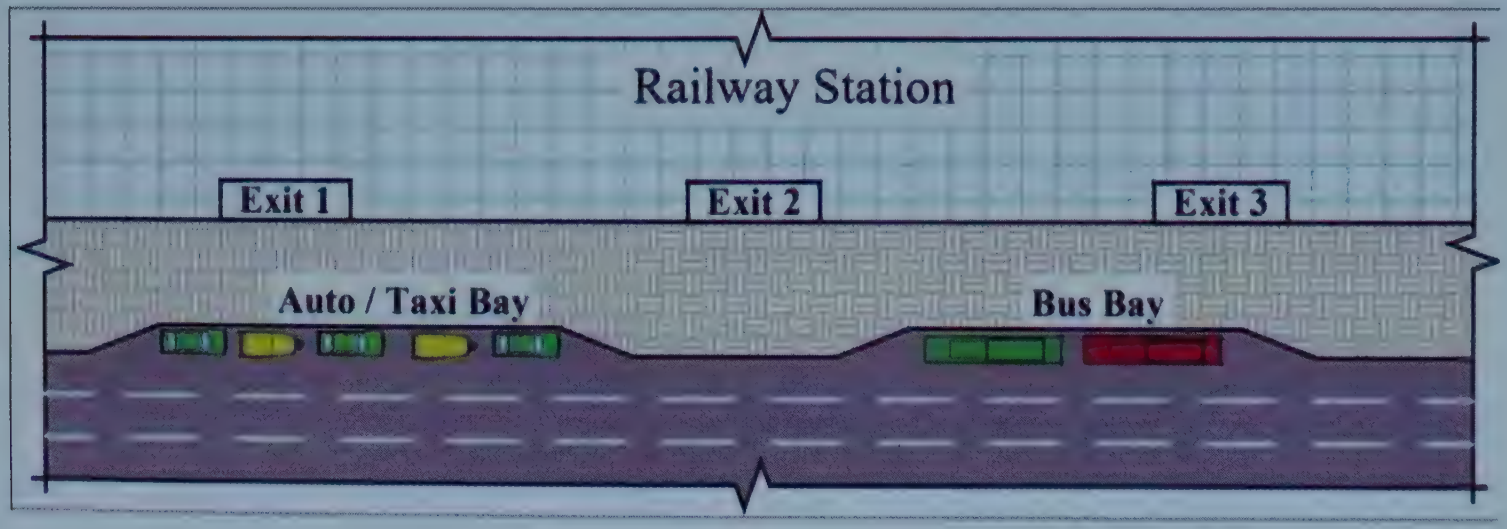

Fig. 5.1 Access to Public Transport (Bus) and Intermediate Public Transport (Taxi/Auto) at Railway Station

Fig. 5.2 shows the possible simple design at railway stations to ensure easier multimodality of terminals giving choices to passengers.

As presented in **Fig. 5.2**, at the railway station, the closest access should be for bus and/or metro rail (i.e. public transport modes). This access to public transport and other access modes should be designed without any road crossing, as the first preference.

Access to private vehicles and taxi services can be provided at farther distance and with lower priority than at least one public transport mode. An example of an airport terminal having bus stop at exit is shown in **Fig.5.2** along with path marking signage indicating direction and distance from exit gate to bus stop.

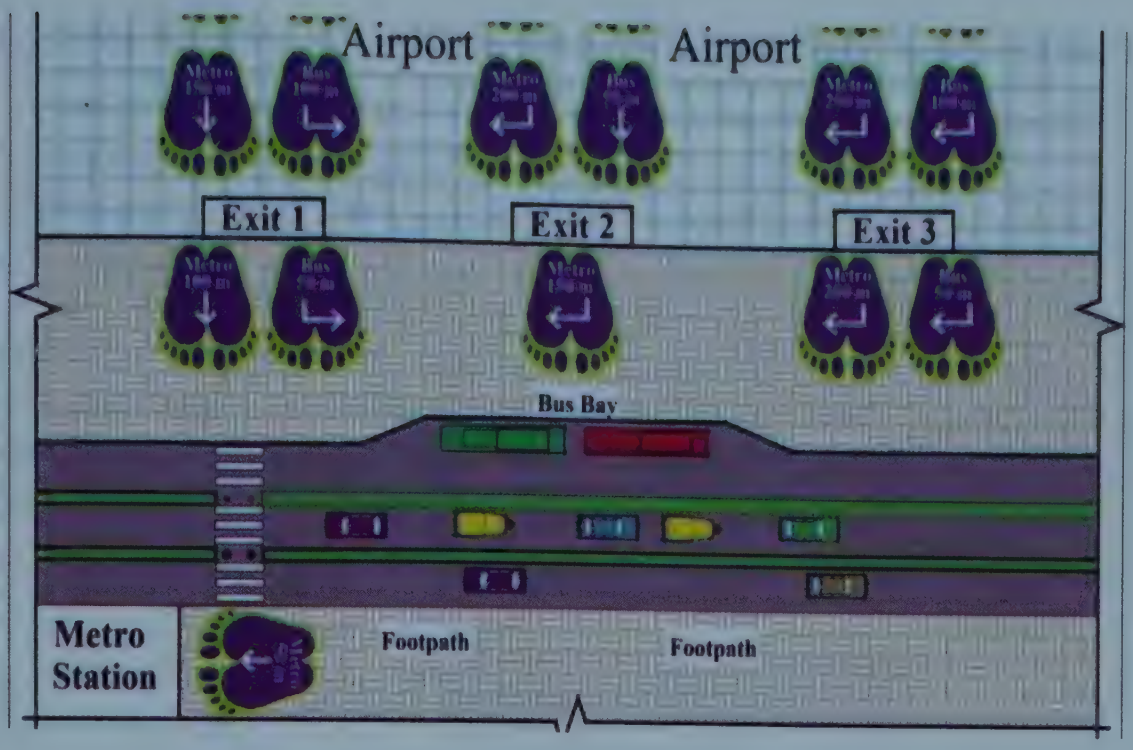

Fig. 5.2 Design for Access/Egress Modes for Airport

6 QUANTIFYING THE LEVEL OF MULTIMODALITY AND WARRANTS FOR ADOPTION

Various ways of improving multimodality at various terminals are possible by reorganizing the circulation network in the access zone of the terminal area, adopting the principles as discussed in previous sections.

A tool, based on the principles discussed, which can quantify the level of multimodality will be helpful to understand existing level of multimodality at a given terminal as well as for a comparison with alternative scenarios. This tool, a part of this document, provides a systematic method to quantify the level of multimodality, based on a few primary data.

For wide adoptability of the tool, data requirement is kept simple and minimum. Data required for using this tool is:

i) Distance from terminal entry/exit gate to nearest location where various access modes are available, i.e. distance from terminal to bus stop, to metro station, to auto-rickshaw stand, to parking for car, and to the pick-up/ drop-off area for taxi, etc.

ii) Share of passengers reaching to the terminal by various modes. This can be based on data collection for one day (24 hours) at terminal.

Performa for these data collection is given under:

These collected data are used further to measure the level of multimodality provided by the terminal in an Excel tool, which is a part of this document. The tool measures the level of multimodality in two parts, which are then combined into a single score called Multimodality Score (MC).

First part of the score is called infra score. Infra score helps in understanding if the distance from terminal entry/exit gate to various access/egress modes is within comfortable limit or not. This promotes higher priority for non-motorised and public transport modes compared to private vehicles. The second part of the

score is about services provided by various modes in terms frequency, comfort, fare, etc. This is indirectly captured through modal split.

The multimodality score provides the quantification method for measuring the level of multimodality. At the same time, it provides information on the scope of improvement possible, i.e. a low infra score highlights the need for better infrastructural connectivity, and a low service score highlights the need for improved services, i.e. frequency, fare, comfort, safety, travel time, etc.

Impact of every single improvement gets reflected in terms of change in score value, and therefore, can be utilized as a decision-making tool. At the design stage also, infra- score helps in finalizing the location of bus stops/metro stations, auto-rickshaw stands, parking areas, etc. At the operation stage, the service score gets updated with change in provided services, which is reflected in the patronage of different modes for access/egress.

Multimodal Transport Terminal **Data Collection Format**			
Date:		**City Name:**	
Terminal Type (Tick the one surveyed)			
Airport	**Railway Station**	**Metro Station**	**Bus Stop/Terminal**
Waterway Terminal	**Ropeway Terminal**	**Other (specify):**_____	
In the case of AIRPORT, the Distance from the Terminal to City-Centre (km)			

Distance from Terminal Entry/Exit Gate:	
Mode	**Distance (meters)**
To the nearest metro station	
To the nearest bus stop	
To the nearest auto-rickshaw stand	
To the nearest car parking location	
To the nearest car drop-off location:	
To the nearest two-wheeler parking location:	
To the nearest taxi pick-up/drop-off location:	
To the nearest two-wheeler taxi pick-up/drop-off location:	
To the nearest cycle stand:	
.....	

Number of Commuters/Passengers reaching to the Transport Terminal by various modes (24 hours of a typical day)		
Mode	Number of Commuters reaching to airport (nos.)	Number of Commuters reaching to airport (% share)
By Metro:		
By Bus:		
By Auto-Rickshaw:		
By Car:		
By Taxi:		
By Two-wheeler Taxi:		
By Motorised Two Wheeler:		
By Bicycle:		
By Walk:		
Any other mode:		
.....		

7 TOOL TO MEASURE THE LEVEL OF MULTIMODALITY

This Excel tool measures the level of multi-modality at a terminal. This will be applicable to all types of terminals, whether serving intra-city or inter-city trips. The terminal can be of any particular transport mode, i.e. airport, railway station, interstate bus terminal, normal bus stop, metro station, ropeway station, or even waterway station, etc. However, a terminal is supposed to facilitate access/egress through all other modes for efficient multimodal operation. Such multimodality of a terminal can be assessed through the Excel tool, which is based on two aspects (1) infrastructural facilities (Infra Score) and (2) service facilities (Service Score). **Fig. 7.1** describes the basic structure of the tool.

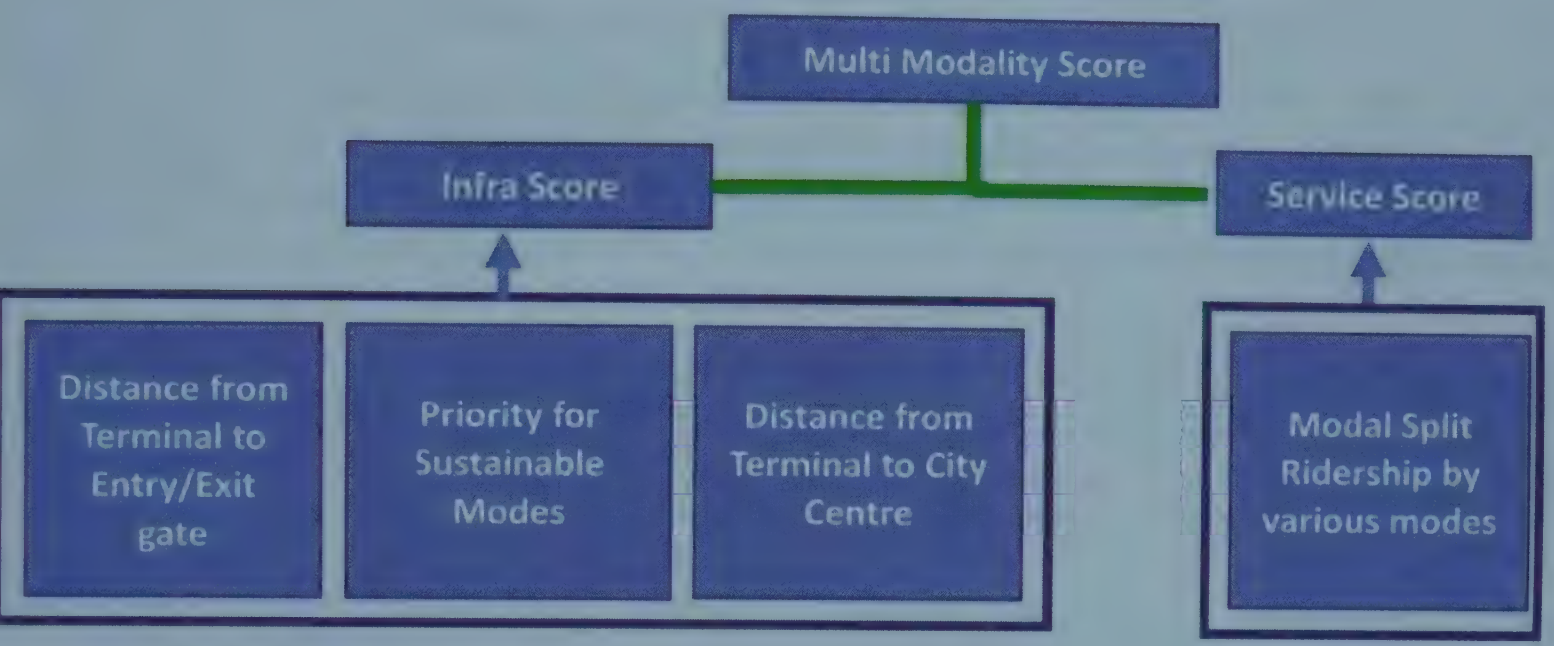
Multi Modality Score
Infra Score
Service Score
Distance from Terminal to Entry/Exit gate
Priority for Sustainable Modes
Distance from Terminal to City Centre
Modal Split Ridership by various modes

Fig. 7.1 Concept of Score Calculation

7.1 Infra Score

The Infra Score is to measure infrastructural provisions in the terminal for handling multimodality.

Data required for calculating Infra score is:

7.1.1 Distance from terminal entry/exit gate to location of various modes: Measured distance in meters from terminal entry/exit gate to the location of each mode available for making access/egress trip (i.e. parking area, bus stop, metro, train station, auto stand, etc.):

i) In case of multiple entry/exit gates at the terminal, the average distance from all the gates is to be considered.

ii) Distance to be calculated after deducting the distance covered by automated ways, i.e. escalators, travellator, lifts, etc.

iii) In case distance for arrival and departure is different, farthest one is to be considered.

Infra score measures the level of multi-modality provided through the access network design around the terminal. It calculates the score based on two criteria, i.e. (1) distance at which various modes (public, intermediate public and private transport modes) are available from the entry/exit gate of the terminal, and

(2) relative distances among public transport, intermediate public transport and private modes. This relative distance is considered to assess the priority provided for sustainable modes, i.e. public transport and non-motorized transport modes over IPT, and similarly priority of IPT modes over the private modes. Apart from these two criteria, an additional third criteria is included especially for airports, which is the distance of the airport from the city center. The average of these three components of evaluation scores is called the Infra-Score of the terminal for multimodality. In case of terminals other than airport there will be only two components in infra-score.

For the first criteria, average distance from terminal entry/exit gate to the location where PT (bus, metro) and NMT (cycle, cycle rickshaw) modes is considered (AD_PT_NMT). Similarly, average distance from terminal entry/exit gate to the location, where motorized IPT modes (Auto and other IPT) are available, is considered (AD_IPT). In addition, the average distance from terminal entry/exit gate to the location, where private vehicles (car, taxi, MTW) are available, is considered (AD_PVT).

To ensure the priority of sustainable modes over intermediate public transport modes, differences of these distances considered above are compared. Apart from the absolute value of the difference in distance for AD_PT_NMT and AD_IPT, the positive or negative sign is being assigned to ensure priority, as mentioned in **Table 7.1** below

Table 7.1 Infra Score IS1 Based on the Difference Between Average Distance for Public and Non-Motorized Transport and Intermediate Public Transport

Difference of Distance in m AD_PT_NMT and AD_IPT	If Sustainable Modes are Farther than IPT AD_PT_NMT > AD_IPT Assigned Score	If Sustainable Modes are Closer than IPT AD_PT_NMT < AD_IPT Assigned Score
<=100 m	0	100
100 to 200	-10	90
200 to 300	-20	80
300 to 400	-30	70
400 to 500	-40	60
500 to 600	-50	50
600 to 700	-60	40
700 to 800	-70	30
800 to 900	-80	20
900 to 1000	-90	10
>1000 m	-100	0

Similarly, to ensure priority of intermediate public transport modes over private modes, difference of their average distances are compared. Apart from absolute value of difference in distance (for AD_PT_IPT and AD_PVT), positive or negative sign is being assigned, to ensure priority, as mentioned in **Table 7.2**.

Table 7.2 Infra Score IS2 Based on the Difference Between Average Distance for Intermediate Public Transport and Non-Motorized Transport

Difference of distance in m AD_IPT and AD_PVT	If Sustainable Modes are Farther than IPT AD_IPT_ > AD_PVT Assigned Score	If Sustainable Modes are Closer than IPT AD_IPT < AD_PVT Assigned Score
<=100 m	0	100
100 to 200	-10	90
200 to 300	-20	80
300 to 400	-30	70
400 to 500	-40	60
500 to 600	-50	50
600 to 700	-60	40
700 to 800	-70	30
800 to 900	-80	20
900 to 1000	-90	10
>1000 m	-100	0

Finally, the infra score for any terminal except airport is calculated as the weighted sum of the above two scores, i.e. 0.4(IS1) and 0.6(IS2), which indicates a 40% weightage for location preference of PT-NMT over IPT and 60% weightage for location preference of IPT over PVT.

However, in case of airport, one more infra score IS3 is being considered based on distance of the airport from the city center as indicated in **Table 7.3** below.

Table 7.3 Infra Score IS3 for Airports Based on the Distance from Airport to City Center

Distance from City Centre	Infra Score IS3
<=10 km	100
10 to 15 km	90
15 to 20 km	80
for 21 to 50	100 - (2*distance)
>50	0

In case of airport, infra score is being calculated as the average of above three scores (i.e. average of IS1, IS2 and IS3). The final score is normalized as 0 to 100. Normalized value has been calculated using standard formula

Normalized value = (xi – min(x)) / (max(x) – min(x)) * 100

Higher the score better the multimodality at the terminal. Lower infra score demands the better design options to bring access modes of public transport/IPT closer than access to personalized modes. Infra score of airport can be compared to another airport and/or same airport for alternate conditions, but cannot be compared with another type of terminal, i.e. railway station/metro station/bus terminal, etc.

The scores that have been assigned for the comparative distances and also the distance of the airport from city center in **Tables 7.1, 7.2 & 7.3** are based on current knowledge of the merits in such conditions. After several assessments of terminals for multimodality the assigned scores and also the weightage for IS1 and IS2 may be updated and modified.

7.2 Service Score

The second aspect in the merit of the terminal in multimodality is in terms of the patronage of various modes for access/egress trips to/from the terminal. This indicator reflects the level of convenience enjoyed by traveler in use of different modes for accessing the terminal. Therefore, level of patronage is considered as the result of offered comfort, availability, affordability, safety, etc.

Accordingly, data required for calculating this score is Modal split for access/egress trips i.e. The proportion of access/egress trips made by various modes by the passengers and employees (working at the terminal) is to be collected. (Format for this data collection is being included in Section 5).

Thus, the modal share in access/egress mode indicates the level of service in terms of multimodality provided to commuters. Along with the proportion of access/egress trips made by various modes (modal split), a coefficient of priority is being introduced. Public transport and non-motorized transport being the most sustainable modes, these are given highest weightage of 1.0. Intermediate public transport modes are assigned a value of 0.5 being 'medium level priority' and private vehicles are being assigned with the value of -1 to discourage its usage while designing the multimodality at terminals.

After assigning these coefficients, minimum and maximum value of possible service score is minus100 and 100 respectively. Minimum value of minus100 is possible when all the passengers are accessing the terminal by private motorized vehicles and maximum value of 100 is possible in case all commuters are accessing the terminal either by public transport or non-motorized modes. This value has been normalized to bring between 0 and 100 for easier interpretation. Normalized value has been calculated using standard formula

Normalized value = (xi – min(x)) / (max(x) – min(x)) * 100

Infra and Service Scores for a few hypothetical examples have been presented below.

Example 1: Given data

At an airport, various modes of transportation are available at varying distances to perform access/egress trips using these modes. These modes and their respective distances from airport's entry/exit gate to the actual location, where these vehicles are available, are given in the table. Also, the proportion of various access/egress modes used by the passengers and employees is given in the table. Calculate the level of multi-modality at this airport. The distance of the airport from the city center is 15 km.

Distance (km) from Terminal entry/exit gate to the nearest:		
Mode Type	**Distance in meters between the place where access/egress mode is available (stand/stop/parking) and place of airport/railway station's entry/exit gate(s)**	**Access Modal Split**
Metro	500	20
Bus	500	10
Car (taxi)	250	35
Car (personalised)	100	20
MTW (taxi)	100	0
MTW (personalised)	100	15
Cycle	100	0
Auto rickshaw	100	0
Cycle rickshaw (all	100	0
Other IPT	100	0

Solution 1:

STEP 1: Place user data into the given excel sheet appropriately

Cell Code	A	B
6	**Distance (km) from Terminal entry/exit gate to the nearest:**	
7	Vehicle Type	Distance (meters)
8	Metro Station	500
9	Bus Stop	500
10	Car (taxi) Pick up Point	250
11	Car Parking (personalized)	100
12	MTW (taxi) Pick up point	100
13	MTW Parking (personalized)	100
14	Cycle Parking	100
15	Auto rickshaw Stand	100
16	Cycle rickshaw (all types)	100
17		
18	other IPT	100
Note: In case of Pick up and drop off point for Car (taxi) and Two (taxi) is different, consider the distance from drop off point		

STEP 2: Calculating average distance for public transport, intermediate public transport and private mode options

Cell Code	A	B
38	**AD_PT_NMT** Average PT (bus, metro) & NMT (cycle, cycle rickshaw)	= AVERAGE (B8, B9, B14, B16, B17) = (500+500+100+100)/4 = 300
39	**AD_IPT** Average of motorized IPT (Auto and other IPT)	= AVERAGE (B15, B18) = (100+100)/2 = 100
40	**AD_PVT** Average personalized vehicles (car taxi, car, MTW taxi, MTW)	= AVERAGE (B10, B11, B12, B13) = (250+100+100+100)/4 = 137.5
41	Difference between distances of PT_NMT and IPT	= Cell_B38 – Cell_B39 = |300 – 100| = 200
42	Difference between distances of IPT and PVT	= Cell_B39 – Cell_B40 = |100 – 137.5| = 37.5

STEP 3: Checking priority for public transport over intermediate public transport

Cell Code	Value of Cell B41	if Cell B38 > Cell B39 Calculate Value for Cell F44	if Cell B38 < Cell B39 Calculate Value for Cell G44
		F	G
44	<=100m	0	100
45	**100 to 200**	**-10**	90
46	200 to 300	-20	80
47	300 to 400	-30	70
48	400 to 500	-40	60
49	500 to 600	-50	50
50	600 to 700	-60	40
51	700 to 800	-70	30
52	800 to 900	-80	20
53	900 to 1000	-90	10
54	>1000m	-100	0

Calculate Value for Cell_G19

- If B38 = B39, value is 100
- If B38 > B39, value is F44
- If B38 < B39, value is F56

At this step, it is checked "whether the criteria of the higher priority for public transport compared to intermediate public transport" is being assured and a score is assigned based on the level of difference. This has a role in overall score of multimodality.

STEP 4: Checking priority for intermediate public transport over personalized modes

Cell Code	Value of Cell B42	if Cell Value B39 > Cell Value B40 Calculate Cell F68	if Cell Value B39 < Cell Value B40 Calculate Cell G68
		F	G
68	<=100m	0	**100**
69	100 to 200	-10	90
70	200 to 300	-20	80
71	300 to 400	-30	70
72	400 to 500	-40	60
73	500 to 600	-50	50
74	600 to 700	-60	40
75	700 to 800	-70	30
76	800 to 900	-80	20
77	900 to 1000	-90	10
78	>1000m	-100	0

Calculate Value for Cell_G43

- If B39 = B40, value is 100
- If B39 > B40, value is F68
- If B39 < B40, value is F80

STEP 5: Calculation for the access distance of airport

Cell Code	Distance from City Centre	Infra Score S3
		B
107	<=10 km	100
108	10 to 15 km	90
109	15 to 20 km	80
110	for 21 to 50	100 - (2*distance)
111	>50	0

he distance from airport to city center is 15 km. (input to cell B104) Cell B109 = 80 (from table)

STEP 6: Calculation of multimodality infra score

In case of airport, Multimodality Infra Score S = (G44 + G68)/2
= (-10+100)/2
= 45

STEP 7: Calculation of service score

alculating the proportion of trips by public transport, intermediate public transport and private mode ptions

Cell Code	A	B
95	**Proportion PT_NMT** The sum of proportion of trips by PT (bus, metro) & NMT (cycle, cycle rickshaw)	= sum (B24, B25, B30, B32, B33) = (20+10+0+0) = 30
96	**SUM_IPT** The sum of proportion of trips by motorized IPT (Auto and other IPT)	= sum (B31, B34) = (0+0) = 0
97	**AD_PVT** The sum of proportion of trips by personalized vehicles (car taxi, car, MTW taxi, MTW)	= sum (B26, B27, B28, B29) = (35+20+0+15) = 70
98	Calculation of Service Score	Cell Value B95 + 0.5* Cell Value B96 - Cell Value B97 = 30 + 0 – 70 = -40
99	Final Normalized Service Score S =	(Cell Value B98-(-100))/(100-(-100))*100 = 30

STEP 8: Interpretation of score values

Final terminal score= (B105+G99+G91)/3= 51.67

Infra score of 56.67 indicates the need for improvement.

Since the Average distance of PT & NMT is more (>) than the average distance of IPT, score can be improved by providing PT and NMT stop/stand closer than IPT stop/station. Service score of 30 indicates lower ridership by sustainable modes. This can be improved by improving frequency, comfort, fare policy, safety, etc. apart from the design improvement which gets reflected in the Infra score value.

Example 2: Given data

At a railway station, various modes of transportation are available at varying distances to perform as access/egress trip. These modes and their respective distances from airport's entry/exit gate to the actual location, where these vehicles are available, are given in the table. Also, proportion of various access/egress modes used by the commuters is given in the table. Calculate the level of multi-modality at this railway station.

Mode Type	Distance in meters between the place where access/egress mode is available (stand/stop/parking) and place of airport/railway station's entry/exit	Access Modal Split
Metro	500	20
Bus	500	10
Car (taxi)	250	35
Car (personalised)	100	20
MTW (taxi)	100	0
MTW (personalised)	100	15
Cycle	100	0
Auto rickshaw	100	0
Cycle rickshaw (all types)	100	0
Other IPT	100	0

Solution: *Refer to Excel Tool provided with this document*

STEP 1: Place the user data into excel sheet cell range B8:B18

Cell code	A	B
7	Vehicle Type	Distance (meters)
8	Metro Station	500
9	Bus Stop	500
10	Car (taxi) Pick up Point	250
11	Car Parking (personalised)	100
12	MTW (taxi) (distance from Pick up point)	100

13	MTW (personalised) (distance from Parking location)	100
14	Cycle Parking	100
15	Auto rickshaw Stand	100
16	Cycle rickshaw (all types)	100
17		
18	Other IPT	100

Note: In case of Pick up and drop off point for Car (taxi) and Two Wheeler (taxi) is different, consider the distance from drop off point

STEP 2: Calculating average distance for public transport, intermediate public transport and private mode options

Cell Code	A	B
38	**AD_PT_NMT** Average PT (bus, metro) & NMT (cycle, cycle rickshaw)	= AVERAGE (B8, B9, B14, B16, B17) = (500+500+100+100)/4 = 300
39	**AD_IPT** Average of motorized IPT (Auto and other IPT)	= AVERAGE (B15, B18) = (100+100)/2 = 100
40	**AD_PVT** Average personalized vehicles (car taxi, car, MTW taxi, MTW)	= AVERAGE (B10, B11, B12, B13) = (250+100+100+100)/4 = 137.5
41	Difference between distances of PT_NMT and IPT	= Cell_B38 – Cell_B39 = |300 – 100| = 200
42	Difference between distances of IPT and PVT	= Cell_B39 – Cell_B40 = |100 – 138| = 38

STEP 3: Checking priority for public transport over intermediate public transport

Cell Code	Value of Cell B41	if Cell B38 > Cell B39 Calculate Value for Cell F44	if Cell B38 < Cell B39 Calculate Value for Cell G44
44	<=100m	0	100
45	**100 to 200**	**-10**	90
46	200 to 300	-20	80
47	300 to 400	-30	70
48	400 to 500	-40	60
49	500 to 600	-50	50
50	600 to 700	-60	40
51	700 to 800	-70	30
52	800 to 900	-80	20
53	900 to 1000	-90	10
54	>1000m	-100	0

Calculate Value for Cell_B41

- If B38 = B39, value is 100
- If B38 > B39, value is F44
- If B38 < B39, value is F56

STEP 4: Checking priority for intermediate public transport over personalized modes

Cell code	Value of Cell_B42	if Cell Value B39 > Cell Value B40 Calculate Cell F68	if Cell Value B39 < Cell Value B40 Calculate Cell G68
68	<=100m	0	**100**
69	100 to 200	-10	90
70	200 to 300	-20	80
71	300 to 400	-30	70
72	400 to 500	-40	60
73	500 to 600	-50	50
74	600 to 700	-60	40
75	700 to 800	-70	30
76	800 to 900	-80	20
77	900 to 1000	-90	10
78	>1000m	-100	0

Calculate Value for Cell_B42

- If B13 = B14, value is 100
- If B13 > B14, value is F68
- If B13 < B14, value is F80

STEP 5: This step is applicable for AIRPORT only

STEP 6: Calculation of Multimodality Infra Score

Multimodality Infra Score S = (G44+G68)
= (-10+100)/2
= 45

STEP 7: Calculation of service score

Calculating the proportion of trips by public transport, intermediate public transport and private mode options

Cell Code	A	B
95	**Proportion PT_NMT** The sum of proportion of trips by PT (bus, metro) & NMT (cycle, cycle rickshaw)	= sum (B24, B25, B30, B32, B33) = (20+10+0+0) = 30
96	**SUM_IPT** The sum of proportion of trips by motorized IPT (Auto and other IPT)	= sum (C31, C34) = (0+0) = 0
97	**AD_PVT** The sum of proportion of trips by personalized vehicles (car taxi, car, MTW taxi, MTW)	= sum (B26, B27, B28, B29) = (35+20+0+15) = 70
98	Calculation of Service Score	Cell Value B95 + 0.5* Cell Value B96 - Cell Value B97 = 30 + (.5*0) – 70 = -40
99	Final Normalized Service Score S =	(Cell Value B98-(-100))/(100-(-100))*100 = 30

STEP 8: Interpretation of score values final

terminal score= (G91+G99)/2= 37.5

Infra score of 45 indicates the need for improvement.

Since the Average distance of PT & NMT is more (>) than the average distance of IPT, score can be improved by providing PT and NMT stop/stand closer than IPT stop/station.

Service score of 30 indicates lower ridership by sustainable modes. This can be improved by improving frequency, comfort, fare policy, safety, etc. apart from the design improvement which gets reflected in the Infra score value.

8 RELEVANT CODES, GUIDELINES AND REPORTS

This document has been prepared as a guideline for developing the multimodal terminals. There are many other IRC, IS and other guidelines from various organizations, which can provide very important insights and development criteria for many aspects, which are not elaborated in this document. Those details are directly considered from these guidelines, and for that reason only all these guidelines are listed here as ready reference for the users of this guideline on multimodal terminals.

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Annexure-1

ROAD GEOMETRICS FOR AREA AROUND TERMINALS

Salient Features

Road geometrics include a systematic orientation of physical features that may be necessary for the safe, efficient, and convenient use of roads by motor vehicles, pedestrians and non-motorised vehicles. Various IRC codes area available to address these physical features to ensure the lower/reduced speed, as in terminal area pedestrian and NMT movement is expected to be high. Road markings and signages in the road network of the surrounding area of terminal are also to be ensured. The design, placement, operation, and maintenance of the road traffic signages can be found in IRC:67. The design, specifications, and application of road markings at different locations can be found in IRC:35. For comprehensive guidelines regarding traffic signals may be found in IRC: 93.

Specific User Facilities

A.1 Pedestrian

Pedestrian facilities are the foundation of multimodal transportation system as all commuters are pedestrian at the point of accessing the transfer mode of travel. Safe walking facilities provide an alternate mode of travel with added benefits of reducing congestion and pollution while encouraging healthy lifestyle. IRC Code for pedestrian facility is IRC: 103.

The design elements for pedestrian facility include sidewalks, kerbs and crossing facilities, which are to be exclusively used by pedestrians.

A.2 Sidewalk/ Footpath

The design guidelines for various elements of pedestrian facilities can be referred in Section 6.1, IRC:103; Section 3.2.1, IRC:SP:117; Pedestrian Facilities in Bicycle/ Pedestrian Circulation section in Multi-modal Handbook, Chester County Planning Commission (Ref.); and Section 4, Chapter 3 of Multimodal Design, Roadway Design Guidelines, Tennessee Department of Transportation (Ref.).

A.3 Kerbs and Detectable Warning Surface

The main design elements for a kerb are its height, radius, slip road and kerb ramp. The design guidelines can be referred in Section 6.2, IRC:103 and Section 3.2.2, IRC:SP:117. Detectable warning source indicate the boundary between pedestrian and vehicular routes where there is a flush connection, and the kerb is absent. The recommendations for detectable warning surface can be referred in Chapter 3 of Multimodal Design, Roadway Design Guidelines, Tennessee Department of Transportation (Ref.).

A.4 Crossing Facilities

The key guidelines, design elements and warrants for different types of pedestrian crossing facilities can be referred in Section 6.7, IRC:103 and Section 3.2.9,IRC:SP:117. ITS and Traffic Signals: Supplement all visual signage and information with audible signals and digital displays (can be referred in Section 3.2.18, IRC:SP:117).

Smart Pedestrian Crosswalk: A multi-functional Cooperative Intelligent Transport System (C-ITS) device which improves safety on unregulated pedestrian crosswalks. It enables monitoring the situation on traffic lanes and sidewalks and has various safety and notification functions implemented which notify the users about existing traffic hazards. It supports various features like Dedicated Short-Range Communication (DSRC), Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication, which can be referred in Smart Pedestrian Crosswalk Brochure, Bercman Technologies (Ref.).

A.5 Other Elements

Pedestrian facilities also include other elements like tactile pavers, ramps, stairs, elevators/ lifts and street furniture. The design guidelines for these elements can be referred in IRC:103 and IRC:SP: 117.

A. 6 Cyclist

A well-structured and established cycle network around terminals, especially bus stops and metro stations, has a potential to improve the ridership of public transport systems. In Indian context, the cycle includes bicycles as well as tri-cycles commonly called as Cycle Rickshaw. IRC:11 and IRC:SP:117 provides more information regarding Bicycle Facilities in Bicycle/ Pedestrian Circulation section in Multi-modal Handbook. Various elements like use of pavement material for cycle track/lane surface, provision of signage and marking, incorporation of street furniture, lighting and various other support facilities can be referred in Section 7, IRC:11 and IRC:SP:117. The key elements of cycle parking are location of facility, space/ area of parking, theft control, and shaded facility (can be referred in Section 8, IRC:11). The guidelines for providing a bicycle sharing facility and design of various elements can be referred in Public Cycle Sharing Systems: A planning toolkit for Indian Cities, National Public Bicycle Scheme, Institute for Transportation and Development Policy, Ministry of Urban Development, (Now Ministry of Housing and Urban Affairs), Government of India. Good lighting design around terminals brings many benefits including safety and security of all road users. IRC:86 can be referred to estimate the illumination requirements in terminal area.

A. 7 Inclusive Infrastructure

Every segment and junction of the road network should also ensure the smooth movement for different modes and the pedestrian having different needs. This also includes the boarding and de- boarding area to have ramps, tactile paving, etc. All these must comply to the requirements of universal accessibility.

Here, universal and/or inclusivity means consideration for all type of mode users and all type of population while designing road infrastructure. This includes all gender groups, all age groups, groups of ranging financial capabilities, persons with any different needs, etc.

Inclusive designs influence the mode choice behaviors of commuters and therefore the mobility and the accessibility, therefore, enough attention is required to be considerate.

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the Code/Guidelines/ Manual etc. from the date specified therein)

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